HARMONIC MODELING IN POWER DISTRIBUTION SYSTEM USING TIME SERIES SIMULATION

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Specially dedicated to my beloved parents, husband
and for those who have
encouraged, guided, supported and inspired me

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ABSTRACT

Harmonic distortion is one of the major power quality concerns. The non-linearity of customer loads caused the occurrence of harmonic distortion that leads to degradation of power system components. Therefore, harmonic studies have become an important part in power system modeling, simulation and analysis. The needs for harmonic modeling and simulation are to determine the existence of dangerous resonant conditions and to verify that the distortion level complies with the standard harmonic limits. This research is to model time-series harmonic analysis. An integration of Open Distribution System Simulator (OpenDSS) with Microsoft Visual C++ and Microsoft Excel into an application for time-series simulation control is presented. Harmonic power flow analysis is performed by using OpenDSS interfaced with C++ to simulate the time-series simulation. The impact of practical harmonic loads measured from commercial, industrial and residential sectors on different distribution network systems are investigated. Two test case studies, with and without harmonic loads are modeled to show the usefulness of time-series simulation. IEEE test feeder and practical power distribution system are used as the test system for both case studies. The impact of harmonics on the test systems is studied by using the measured harmonic data obtained from logging sites. The simulation results were compared with the standard harmonic limits to ensure the compliance of distortion levels. Simulation results obtained show that total harmonic distortion has a significant effect on the losses of the system, mainly on the lines, cables and transformer losses. The losses of the system with harmonics for both types of the test system showed an increment compared to the system without harmonics. Hence, this proves that when harmonics exist within the system, losses increase. Based on the simulation results acquired using the developed application, the system losses and the level of harmonic distortions in the electric power distribution network are easily obtained for each interval of time-series. The developed application saves computational time as well as providing a method that is cost effective.

ABSTRAK

Herotan harmonik merupakan salah satu daripada masalah utama kualiti kuasa. Ketidaklurusan beban pelanggan telah menyebabkan berlakunya herotan harmonik yang membawa kepada kerosakan komponen sistem kuasa. Oleh itu, kajian harmonik telah menjadi penting dalam permodelan sistem kuasa, simulasi dan analisis. Keperluan untuk permodelan dan simulasi harmonik adalah untuk menentukan kewujudan keadaan resonan berbahaya dan untuk mengesahkan bahawa tahap herotan mematuhi had piawaian harmonik. Penyelidikan ini adalah untuk memodelkan analisis siri masa harmonik. Integrasi OpenDSS dengan Microsoft Visual C++ dan Microsoft Excel kepada satu aplikasi kawalan simulasi siri masa telah dibentangkan. Analisis aliran kuasa harmonik telah dilakukan menggunakan OpenDSS dengan C++ untuk simulasi siri masa. Kesan beban harmonik praktikal yang diukur dari sektor komersil, perindustrian dan perumahan pada sistem rangkaian pengagihan yang berbeza dikaji. Dua kes kajian, dengan beban harmonik dan tanpa beban harmonik dimodelkan untuk menunjukkan kegunaan simulasi siri masa. Sistem rangkaian IEEE dan sistem pengagihan kuasa praktikal digunakan sebagai sistem ujian untuk kedua-dua kajian kes. Kesan harmonik ke atas sistem ujian dikaji dengan menggunakan data harmonik yang diperolehi. Keputusan simulasi dibandingkan dengan had piawaian harmonik untuk memastikan kepatuhan tahap herotan tersebut. Keputusan simulasi yang diperolehi menunjukkan bahawa jumlah herotan harmonik mempunyai kesan ke atas kehilangan kuasa sistem, terutama pada talian, kabel dan pengubah. Kehilangan kuasa sistem dengan harmonik untuk kedua-dua jenis sistem ujian menunjukkan peningkatan berbanding dengan sistem tanpa harmonik. Maka, ini membuktikan apabila harmonik wujud di dalam sistem, kehilangan kuasa meningkat. Berdasarkan kepada keputusan simulasi yang diperolehi menggunakan aplikasi yang telah disiapkan, kehilangan kuasa sistem dan tahap herotan harmonik dalam rangkaian pengagihan kuasa elektrik mudah diperolehi untuk setiap selang siri masa. Aplikasi yang dibangunkan menjimatkan masa pengiraan dan juga menyediakan satu kaedah yang kos efektif.